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LIGHTHOUSE ILLUMINANTS.[1]

IT will be remembered that some years ago the Trinity House appointed a committee to carry out experiments at the South Foreland with a view of investigating the relative advantages of oil, gas, and electricity as lighthouse illuminants. Three experimental towers were erected, and were appropriated respectively to electricity, to Mr. Wigham's gas apparatus, and to oil, with occasional gaslights. Each lighting system was adapted to be shown in the multiform arrangement; i.e., with lights placed vertically one above the other. For gas, provision was made for showing four lights, while the electric and oil systems had three lights each. Observers were placed in huts at distances of 2,144 feet, 6,200 feet, and $2\frac{1}{2}$ miles. For observations at greater distances, advantage was taken of the services of the coastguard between the North Foreland and Dover; of the lightmen on the "Gull," the "Goodwin," and the "Varne" lightships; of the lighthouse-keeper at the North Foreland; of pilots and masters navigating in the vicinity; and of the Elder Brethren and their officers. More than six thousand observations were taken. The conclusions arrived at were, (1) that the electric light was the most powerful under all conditions; (2) that the quadriform gas apparatus and the triform oil apparatus were of about the same power when seen through revolving lenses, the gas being "a little better" than the oil; (3) that through fixed lenses the superiority of the gaslight was unquestionable (the large size of the flames and their nearness together gave the beam a more compact appearance); (4) that the Douglass gas-burner was more efficient than the Wigham burner; (5) that for the ordinary necessities of lighthouse illumination mineral oil was the most suitable and economical illuminant, and that for salient headlands, important landfalls, and places where a very powerful light was required, electricity offered the greatest advantages.

This report did not please the advocates of gas. Memorials were poured into the Board of Trade from ship-owners, both individuals and associated bodies, asking that the experiments might be continued with duplicated gas apparatus of Wigham's pattern, this being understood to give greatly increased brilliancy. The board replied that they were informed that these experiments would cost £18,000, in addition to the £9,000 already spent, and that the state of the Mercantile Marine Fund would not allow of such an expenditure. Mr. Wigham characterized the estimate as "monstrous," and subsequently undertook to guarantee the expense should not exceed £2,000, if the existing apparatus were used, and the services of the various employees given. The Trinity House replied that a great deal of the apparatus had been put into actual service elsewhere, and that Mr. Wigham had ignored the expense of establishing multiform oil and electric lights in comparison with his multiform gaslights.

Another objection brought against the report was that the final conclusion of the Trinity House ignoring gas was not justified by the record in the report itself. It was therefore urged upon the board that the report should be remitted to some independent scientific authority to determine if the evidence bore out the conclusions. Eventually this course was adopted, and the report sent to Sir George Stokes, president of the Royal Society, who associated with himself Lord Rayleigh and Sir William Thomson. These gentlemen have now reported to the Board of Trade at very considerable length, and, while their conclusions bear out to a large extent those arrived at by the Trinity House, yet they are distinctly more favorable to gas. They admit that it was quite natural that the splendid lights erected on the Wigham system on some parts of the Irish coast should have raised in the minds of ship-owners a feeling in their favor; but they point out that the question at issue does not relate to what has been done in the past, but that it is, "Does gas possess such advantages over oil as to outweigh the greater simplicity and economy of the latter illuminant, and should both, in the case of lights of special importance, be abandoned in favor of electricity?"

The 108-jet gas burner gives a broader flame than the 6-wick oil-burner; and with lenses of similar apertures and focal lengths, and equal velocities of rotation, the diverging beam from the gas is of longer duration. This has been taken advantage of by Mr. Wigham for the introduction of a group flashing system, by which it is sought to give each light a distinctive character. The report states, however, that with revolving lights the number of flashes in a group is somewhat uncertain; with fixed lights there is no such uncertainty. The intermittence of a revolving light is obtained very sharply and suddenly, by turning the gas completely out, and by relighting it with a burst, resulting from allowing the gas to flow for an appreciable time before the flame is applied. With oil, intermittence can only be obtained by means of shutters, as it is not feasible to turn the light out. When the Wigham burner was compared with the Douglass burner, it was found that the latter gave the more light for a given consumption of gas. The smaller size of the flame also augmented the brightness of the flash. The Douglass burner, however, requires a glass chimney, which may give

[1] From Engineering of Oct. 31.

way, particularly if the flame be turned up rapidly under a sudden fog.

The electric-light apparatus far exceeded the others in the amount of light it gave out. Even in fog and haze it surpassed them; for, although the highly refrangible rays were rapidly dispersed, yet the remaining beam was not more cut down than that from gas or oil, and still maintained its superiority. This great power partly results from the smallness of the luminous area. The high condensation is obtained at the expense of the angular opening of the transmitted beam, which is less than with the taller flames of gas and oil. In practice the upper portion of the full beam must reach the horizon, as seen from the lantern of the lighthouse, while the lower portion must strike the sea at a moderate distance from its foot. It does not appear whether the electric beam employed would have fulfilled both these conditions. If it would not,—and the necessity of adjusting the carbons in certain cases to bring the full beam on to the observers suggests that it would not,—a deduction must be made from its value. Electric lights are practically reserved for revolving lights, the chief object of which is to guide the mariner from long distances. Fixed lights do not need the same far-reaching brilliancy, and it was abundantly proved that for these the gas-burners surpassed the oil-burners employed. Further, gas yields itself with special facility to conferring on a fixed light a distinctive character by means of intermittence.

All the points of difference that we have noted are clearly set forth in the reports, and little difference of opinion exists concerning them. But the advocates of gas claimed for it a special quality; namely, that of diffusing a warning glow through a fog at a distance beyond which the light could be actually seen itself. Sir George Stokes and his colleagues do not profess themselves able to decide whether the extension of distance at which warning will be conveyed by the glow from a gas or other light is such as to be of practical importance. They, however, make some general remarks on the subject, pointing out that the glow or burr is mainly produced by light which has been diffracted, and retains an approximation to its primitive direction. It is deflected from its course by an angle which is not by any means very small, and therefore it cannot matter much whether the regular light from which it originally came was concentrated by the lens within a more or less small angle. The *fog illuminating* power must depend mainly on the quantity of light sent out from the source, while the *fog penetrating* power depends on the concentration of the beam. It follows that the fog illuminating power of the electric light will be much smaller, in proportion to its power for direct penetration, than would be the case with oil, and still more with gas. Conversely, the glow from gas will extend farther beyond the limits of direct penetration of the beam than will the glow from oil, and still more than the glow from electric light. In light fog the direct light would probably be seen first; and, even if it were not, the slight extension of distance resulting from the glow would be of little value. But if the fog were comparatively thick, the ship must approach nearer to the lighthouse, where the illumination of the fog would be stronger, and the luminosity would be seen well before the actual light. This would be rendered more distinguishable from a thinning of the fog if the light was rapidly extinguished and relighted. In the second part of the report Sir Leopold McClintock speaks of "a striking, thrilling effect, which at once caught the eye," produced by cutting off the gas every few seconds. No opportunities, however, occurred for properly estimating the value of this effect, and it could not be taken into consideration in summing up the results of the experiments.

In reviewing the conclusions of the Trinity House committee, Sir George and his colleagues do not propose any serious modifications as to the first four points. (1) They consider the experiments established the superiority of the electric light, as exhibited at the South Foreland, under all conditions of weather. (2) They indorse the statement made as to the relative efficiency of gas and oil for revolving lights. (3) With the fixed lenses they attribute the superiority of gas chiefly to the fact, that, as the light is condensed by the optical apparatus in vertical planes only, the inferiority of the oil-light, as regards the initial quantity emitted, is not compensated for, as with annular lenses, by its superior condensation arising from the smaller width of the flame. (4) While admitting that the photometric measurements establish the superiority of the Douglass over the Wigham burners, as regards economy and efficiency arising from greater concentration of light, they state they have no information as to whether the employment of glass chimneys forms any serious drawbacks. It was the fifth recommendation of the original report that was most strenuously objected to by the advocates of gas, since it practically rejected that illuminant. It is now somewhat modified in form, and the use of gas is referred to, although scarcely recommended. We are now told, (5) "Though gas possesses undoubted advantages over oil in some respects, such as facility in increasing the power on the sudden occurrence of a fog, absence of the necessity of trimming, power of making instantaneous transition from light to darkness, and conversely, we do not think these advantages sufficient to outweigh the advantages which mineral oil possesses for ordinary employment on account of its simplicity and economy. We think, too, that for specially important sea-lights the experiments show that electricity offers the greatest advantages. At the same time, we see no reason for confining the choice to these two alternatives; nor does it appear that the words of the report so confine it. There may be special reasons in particular cases for giving the preference to gas, and it seems even desirable that mariners should have the opportunity of witnessing the effects of different systems, which would thereby be subjected to the test of long continued practical experience." As to the latter part, mariners have long had the opportunity of witnessing the effects of different systems, for several splendid gaslights are to be seen on the Irish coast, while there are electric lights on different parts of the coasts of Britain. Oil-lights, of course, are common enough.

It is not altogether to be wondered at that the Trinity House is disinclined to adopt gas in the present impoverished state of the Mercantile Marine Fund. In the days when that fund was overflowing they could have done so with ease, but now they have only a limited sum to spend on lighting our coasts, and therefore have to make it go as far as possible. The addition of a gas-making plant to a lighthouse means a considerable initial expense, and possibly an increase of working charges. During foggy weather the

light may have to be kept on for several days, and, unless the storage capacity were great, a man would be required specially to work the retorts. Now, since oil-burners are pronounced practically equal to gas for revolving lights, while for fixed lights a great power is not required, it is probably better economy to multiply lighthouses than to increase the outlay on those existing. Besides, the limit of the power of oil-lamps has certainly not yet been reached, and, urged by the rivalry of gas, it is certain that we shall get more powerful burners. Even before the South Foreland experiments were concluded, new and more effective types of burners had been constructed. In places where both light and power are required, as at Ailsa Craig, where there are siren fog-signals in addition to the lighthouse, gas is pretty certain to be adopted in the future, as it simplifies the attendance on the light, and is always at hand to start the air-compressing machinery in case of sudden fog. The production of gas by the distillation of petroleum is so simple that it can easily be learned by the class of attendants employed in lighthouses, and does not sensibly increase the chance of a break-down. It is a pity that the most interesting quality of gas-illumination, that of sky-flashing, was not more fully investigated. This seems to be full of promise. Often the thickness of a fog, measured vertically, is very small, and an intermittent light projected on to the sky could be readily seen Every one knows how the attention is caught by sheet or summer lightning, in which the arch of the sky is momentarily lit up by a flash which is below the horizon, and therefore out of the range of direct vision. Even if the observer have his back to it, he can scarcely fail to see it. According to Sir L. McClintock, something of the same effect can be produced by a sudden burst of flame, produced by turning gas on for a moment before it is lighted. The condition of a mariner groping his way up channel in a thick fog is so dangerous that every expedient that promises to aid him is worth investigation. There are sufficient lighthouses where gas is used to enable this to be tried with scarcely any expense.

THE ARMY-WORM IN MARYLAND.

IN accordance with Professor Riley's instructions, on May 31, accompanied by Mr. Albert I. Hayward of the Maryland Agricultural College, Mr. William H. Ashmead started for Salisbury, Wicomico County, and Princess Anne, Somerset County, Md., to make such observations on the army-worm (*Leucania unipuncta*), then depredating in the vicinity of these places, as the limited time at their disposal should permit.

During the journey (reported in the September bulletin of the United States Department of Agriculture) they ascertained in conversation that the worms were most numerous in the immediate vicinity of Princess Anne, and so they took the most direct route for that place.

As they approached their destination they began to see the effects of the worms' work. Just before entering the town, they passed by a large field of corn, owned by Mr. H. H. Deshields, containing about twelve acres, that had been devastated by the army-worm, and only a few green plants could be detected here and there in the field.

This field was in marked contrast with another corn-field adjacent, which had been saved from attacks by ditching, as recommended in the "Third Report of the United States Entomological Commission." Another thing observed was that this field was flanked behind with a wood that evidently prevented their ingress that way, whereas the former was contiguous to grass and wheat fields, in which the worms are said to originate.

Just before entering the town, another ten-acre corn-field was passed, owned by Mr. John L. Lormer, that but a short time previously presented a most promising appearance, but which is now completely "cleaned out" by the worms. It may be worthy of record, as the theory has been advanced that insects originate in just such places, that in an adjoining field were three old haystacks. Contrary to their expectations, they found the reports of their numbers not at all exaggerated; and the damage done is even worse than was anticipated, the wheat, corn, barley, and timothy of many of the farmers being totally ruined by them.

One of the most interesting places for observation visited was that of William J. Porter, a practical and energetic farmer, who, although he has fought the worms most vigorously, has suffered severely from their attacks. By means of ditching and by burning straw, he has been able to save part of his crops; but several of his fields of corn, timothy, and wheat were already ruined. He reported the worms much less numerous than they had been, but there were many thousands seen in his fields.

During their rambles Mr. Porter took them to one of the ditches he had dug to keep the worms out of a large corn-field. In this ditch he had sunk, every two or three yards apart, deeper pits, where they found the worms two and three inches deep; and the rest of the ditch was black with the dead and living worms. From the dead a fearful stench arose in such strength as to attract the buzzards, which were proudly sailing overhead. Various carrion-beetles, too, seemed to revel in the carnage. Large silphids and staphylinids, besides numerous smaller forms, were quite numerous; while the hard-shelled histerids were quite plentiful, working through the putrid masses. Several carabids were observed running through the ditches, preying on the living and dying; *Scarites subterraneus* Fabr. being particularly noticeable, and no doubt, with its large mandibles, doing efficient service in destroying the worms.

Mr. Porter informed Messrs. Hayward and Ashmead that the worms always originated in the wheat and old grass fields, and during the morning hid themselves from observation, never appearing in numbers until after three o'clock P.M., which accorded with their own observations and with those of the other farmers visited.

They ate up the timothy and corn clean, and, after devouring the blades of the wheat, congregated, three or four together, on the heads. After devouring several of the lower grains, they ate the husks and nipped off the upper portion of the kernel of the rest, thus almost entirely destroying it. If the grain is well advanced and somewhat hard, it escapes destruction; but, as most of the wheat visited was still in the milk, the destruction was great, and not less than 75 per cent of the crop had been already destroyed.

Although several parasites are known to prey upon the worms, and a sharp lookout was kept for such, none were seen except a few cocoons of an *Apanteles*, which were discovered, together with the worms, under old trash and logs in a wheat-field. A few were gathered and forwarded to the Department of Agriculture, some of which have since hatched, and prove to be *Apanteles militaris* Walsh.

The corn-fields of all this region were found to be badly infested with the larvæ of two species of beetles; and so numerous are they at times as to entirely destroy the first planting, and necessitate a replanting of entire fields. The farmers call them the "bud-worm," and do not seem to be aware that they are two distinct species that do the injury.

One species is a well-known corn-pest, the larva of *Diabrotica vittata*, widely distributed over the United States; the other is one of the wire-worms, possibly the larva of a common beetle, *Drastarius elegans* Fabr., which also has an extended range, extending into Mexico. So far as known, this latter species has never before been reported as injurious to corn, as the larva is supposed to be predaceous on other insects. It may, though, have dual habits, not an unusual occurrence in some insects. Both of these species are more prevalent in low fields, the higher fields being less subject to their attacks.

Another beetle, found to be seriously injurious to cantaloupes and sweet-potatoes in this region was a chrysomelid, *Systena*